BULLETIN

OF THE

Society for the Promotion of Engineering Education

Vol. I LANCASTER, PA., JUNE, 1911 No. 11

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EDITORIALS.

A Year of the Bulletin.—This number completes the first volume of the BULLETIN. The next number, if the Society decides to continue its publication, will be issued in September. Through the co-operation of the advertisers it has been possible to publish the BULLETIN without cost to the members by means of rigid economy in other directions. At the Pittsburgh meeting the Society will be called upon to decide whether or not the publication of the BULLETIN shall be continued. Such continuation will require a virtual increase in dues of fifty cents. As the name of the publication indicates, its purpose is to keep the members posted on matters of technical education during the year. While it has not fulfilled the expectation of the editor, it has been able, through

the co-operation of the members, to record many of the important happenings of the year. It is to be hoped that the Society will be able to formulate a plan by which the BULLETIN shall become a permanent institution.

The Convention.—The meeting at Pittsburgh will give an excellent opportunity for the members to study the most remarkable industrial district in this country. In view of this fact the local committee desired as much time as possible in order that a number of inspection trips might be undertaken. The Program Committee regrets that it has not been possible to provide more time for such trips. The local committee has, very wisely, decided that a superficial survey of many manufacturing establishments would be tiresome and unsatisfactory to the members. They have, therefore, selected a few plants for inspection and have arranged optional trips so that specialists in several lines can study the most interesting ones. Every effort will be made to economize time and energy so that the members will be in trim for active participation in the discussions.

One of the most important features of any convention is the opportunity for social intercourse. The Pittsburgh meeting has been planned with this in view. On the evening of Tuesday an informal gathering will be held and on Thursday evening college alumni in the Pittsburgh district will be invited in to meet their former teachers. Between sessions ample time will be allowed for conversation, and luncheon will be served each day in a building conveniently located with respect to the convention building.

NEW MEMBERS.

The Council elected the list of applicants printed in the May BULLETIN and also the following:

CARROLL, H. H., Instructor in Technical Drawing, Tufts College, Tufts College, Mass. 1911

NEWMAN, CHACE, Assistant Professor of Drawing, Michigan Agricultural College, East Lansing, Mich. 1911

OCKERBLAD, A. M., Instructor in Civil Engineering, Michigan Agricultural College, East Lansing, Mich. 1911

SAGE, A. B., Professor of Mechanical Engineering, New Mexico College of A. & M. Arts, Agricultural College, N. M. 1911
SHAW, J. E., Instructor in Civil Engineering, Michigan Agricultural College, East Lansing, Mich. 1911
VAN ALSTYNE, DAVID, Vice-President in Engineering and Manufacturing, Allis-Chalmers Co., Milwaukee, Wis. 1911

APPLICANTS FOR MEMBERSHIP.

ARD, C. E., Professor of Mechanical Engineering and Superintendent of Construction, Mississippi A. and M. College, Agricultural College, Miss. 1911
AVERILL, E. A., Editor American Engineer and Railroad Journal, 140 Nassau St., New York, N. Y. 1911
BISHOP, C. C., Professor of Mechanical Engineering, Buffalo Technical High School, Buffalo, N. Y. 1911
CAUGHEY, R. A., Assistant in Civil Engineering, Pennsylvania State College, State College, Pa. 1911
CODDINGTON, E. F., Associate Professor of Mechanics, Ohio State University, Columbus, Ohio 1911
DAVOUD, V. Y., Engineer, The Telluride Power Co., Provo, Utah .. 1911
DUBOIS, A. D., Assistant Professor of Electrical Engineering, Purdue University, Lafayette, Ind. 1911
FAREWELL, S. P., Instructor in Theoretical and Applied Mechanics, University of Illinois, Urbana, Ill. 1911
EDWARDS, E. J., Director of Engineering Research, Engineering Department, National Electric Lamp Association, Cleveland, O. . 1911
FROST, F. W., Secretary and Treasurer Engineering News, 220 Broadway, New York, N. Y. 1911
GILBRETH, F. B., President, F. B. Gilbreth, Inc., 60 Broadway, New York City 1911
GOLDINGHAM, A. H., Sales Engineer, De la Vergne Machine Co., New York City 1911
HITCHCOCK, G. G., Professor of Physics, Pomona College, Claremont, Calif. 1911
KONDO, SENTARO, Engineer, Department of Public Works, Tokyo District, Doboku Shitchojo, Naimusho, Tokyo, Japan 1911
LEWIS, BROTHER HUBERT, Associate Professor in Engineering, Christian Brothers College, St. Louis, Mo. 1911
MAVER, WILLIAM, JR., Consulting Electrical Engineer and Author, 182 Arlington Ave., Jersey City, N. J. 1911
OSSA, GASTON, Assistant in Physics, Universidad de Chile, Santiago, Chile, S. A. 1911
ROHRER, A. L., Electrical Superintendent, Schenectady Works, General Electric Co., Schenectady, N. Y. 1911

SCHEALER, S. R., Instructor in Electrical Engineering, Lehigh University, S. Bethlehem, Pa..... 1911
SELBY, L. B., Assistant Professor of Mechanical Engineering, New Mexico A. and M. College, Agricultural College, N. M..... 1911
SMITH, J. M., Mechanical and Electrical Consulting Engineer, 220 Broadway, New York, N. Y..... 1911
SNOW, O. L., Instructor in Physics and Electrical Engineering, Michigan Agricultural College, East Lansing, Mich. 1911
THOMPSON, JAMES, with Book Department, McGraw-Hill Publishing Co., 239 West 39th St., New York, N. Y..... 1911
VALENTINE, F. P., General Supt. of Traffic, New England Telephone Co., 201 Devonshire St., Boston, Mass..... 1911
VEAZEY, J. A., Graduate Student Graduate School, Cornell University, Ithaca, N. Y. 1911
WADSWORTH, F. L. O., Consulting and Advisory Engineer, Oliver Bldg., Pittsburg, Pa..... 1911
WALDO, E. H., Assistant Professor of Electrical Engineering, University of Illinois, Urbana, Ill. 1911
WALLER, O. L., Professor of Mathematics and Civil Engineering, State College of Washington, Pullman, Wash..... 1911
WILLIAMS, J. P. J., Assistant Professor of Civil Engineering, Columbia University, New York, N. Y. 1911

LETTERS TO THE EDITOR.

SECRETARY S. P. E. E.,
ITHACA, N. Y.

Dear Sir: Allow me to call your attention to an error on page 132 of Volume XVIII. of the PROCEEDINGS. The matter from the middle of page 132 to the bottom of page 133 was sent by me. I send this word so that it may appear upon any errata sheet that you may find desirable.

Very truly yours,
ALEX. W. MOSELEY.

SECRETARY S. P. E. E.,
ITHACA, N. Y.

Dear Sir: In order that a more correct statement may be made in later volumes than in Volume XVIII. of the PROCEEDINGS, permit me to call your attention to the fact that, since landscape architecture is not a kind of architecture, but

a recognized separate and co-ordinate profession, these two professions should be classified separately in summarizing the membership of the Society by occupation.

Sincerely yours,

J. S. PRAY.

SECRETARY S. P. E. E.,
ITHACA, N. Y.

Dear Sir: In acknowledging the receipt of Volume XVIII. of the PROCEEDINGS, I have to claim the blank on page 355 as mine.

Very truly yours,

FRED RAYMOND.

H. H. NORRIS, SEC. S. P. E. E.,
ITHACA, N. Y.

Dear Sir: I have been looking over the Bulletin of the S. P. E. E. volume 1, No. 8, and I find on Page 448 a rather amusing correction for the January Bulletin, which amounts to only a partial correction. You place H. Y. Benedict at College Station, when in reality he lives in Austin and is at the University of Texas. The correct arrangement should be:

Austin: (University of Texas) H. Y. Benedict, A. C. Scott, T. U. Taylor. (3)

College Station: (Texas Ag. Col.) F. C. Bolton, E. J. Fermier, F. E. Giesecke, J. W. Kidd, J. C. Nagle, R. J. Potts, Chas. Puryear. (7)

Yours truly,

T. U. TAYLOR.

SECRETARY S. P. E. E.,
ITHACA, N. Y.

Dear Sir: A matter which it seems to me ought to come before your Society is that of the compensation of engineers. Strictly speaking this should be looked into and, as far as possible, regulated by an association of the deans of professional schools. While I realize that it presents many difficulties, I am sure something can be accomplished.

A professor in a well known high school has for a long time past conducted a sort of employment agency for the boys who

leave that school either by graduation or in advance of it, and he has so improved the conditions of employment that it is greatly to the interest of the boys to have good records at the school. For example, one of the large institutions in his town was in the habit of taking eight or ten boys every year to be trained for its work. Of course it wanted the best, but it did not want to pay them. The professor investigated the conditions under which they worked and found that they were not getting what they were worth, or in fact what amounted to a decent living. He thereupon reported to the president of the company that the boys could not stay there unless they had adequate promotions in accordance with their terms of service. The first attitude of the corporation officers was one of very earnest resentment, and they informed the dean in turn that it was none of his business and he would please to mind his own business. He then struck the name of the company off the high school list, and put up in the school a notice that it did not treat its boys fairly. Furthermore, he told four of the young men who were employed there to leave the service and provided places for them elsewhere, since the high school is swamped with applications all the time. The result was a visit from the president of the corporation and a decided difference in his tone, but they were kept off the list for a year and had to get boys without high school education. Of course he has the co-operation of the principals of all the high schools in his town, and it is his aim to keep boys out of the "blind alley" occupations.

Now I believe it is possible to deal with the professional situation in somewhat the same way. I do not hesitate to say that in all the large engineering commercial enterprises such as the Edison and the Interborough Companies here and in others of similar character in other places the average professional pay is not what is earned by a good clerk. I know, for instance, engineers who after several years with the corporation are getting $25 a week. These are men of mature years who certainly are entitled to a living salary, of good intelligence and with professional training. Such a

situation would be impossible if the work of the graduate was followed up by the dean and the corporations were given to understand that they could not have graduates of Columbia, Cornell, Tech, Stanford and so on, at any such prices. I realize that when your men graduate they are anxious to get placed at once, and further, that under former systems of education they were not much good for the first six months; but I don't believe that is the case any longer. My experience here in New York and to a certain extent in other places is that it is the younger men who come to the work with fresh points of view (admittedly sometimes too fresh) who make the improvements and do all the harder part of the work; in many cases the manager or chief engineer or even the technical vice-president gets the credit and reads a paper about it at an engineering society meeting.

Such a scheme could only succeed of course when carefully worked out and by the co-operation of all of the first-class schools. I believe it would have the endorsement, if properly presented, of the engineering societies and might in time beget a wholesome *esprit de corps* amongst engineers and some sense of loyalty to the profession; I regret to say that both of these are now generally lacking.

Yours very truly,

T. J. JOHNSTON.

NEW YORK CITY,
March 28, 1911.

Mr. Johnston is a patent attorney of New York City. While not a member of the Society he takes a great interest in matters affecting technical education.—ED.

PROGRAM OF THE PITTSBURG MEETING.

Tuesday, June 27, the Council will meet at 9 a.m. and the opening session of the convention will begin at 10 a.m. in the auditorium of the Applied Science Building of the Carnegie Technical Schools. The following papers will be presented.

Paper: "Teaching English in Technical Schools," by Professor S. C. Earle.

Paper: "The Preparation of Written Papers in Engineering Schools," by Professor Fred. Raymond.

Paper: "Teaching of Scientific Shop Management with Use of Engineering School Shops as the Laboratory," by Professors H. Wade Hibbard and H. S. Philbrick.

Paper: "Highway Engineering," by Professor A. H. Blanchard.

On Tuesday afternoon the report of the Committee on Teaching Mathematics to Engineering Students will be presented by the chairman, Professor E. V. Huntington. Following the discussion of this report Dean C. H. Benjamin will present a paper on the "Balance of Courses in Chemical Engineering" and Professor J. H. James will follow with one on "Chemical Education for the Industries."

After the meeting a dinner at the Country Club will be tendered by Director Hamerschlag on behalf of the Carnegie Technical Schools.

In the evening President Talbot will deliver his annual address, which will be followed by a smoker.

Wednesday, June 28, the Council will meet at 8:45 o'clock and the Society at 9:30 o'clock at the Carnegie Technical Schools, when the following program will be presented.

The Report of the Committee on Entrance Requirements will be introduced by the chairman, Professor J. J. Flather.

Paper: "The Use of Logarithmic Diagrams," by Mr. H. A. Gehring.

Paper: "The Architecture of Engineering Schools," by Professor J. M. White.

Paper: "The Wentworth Institute," by Director A. L. Williston.

The afternoon of Wednesday will be devoted to visits to the various industries of the Pittsburg district. Optional trips will be arranged, so that men in different professions will find matters of interest in their several lines. The main feature of the convention will be a visit to the Homestead Steel Works, but optional trips will be arranged for mechanical, civil, electrical and chemical engineers.

On Wednesday evening Professor J. M. White will deliver an illustrated lecture on "The College Campus." The lecture will be preceded by an executive session and the election of officers.

On Thursday morning the new Council will organize and the meeting will be held at the University of Pittsburg, Thaw Hall. It will be followed by luncheon given by the University. The program for Thursday morning is as follows:

Paper: "An Engineering Course for Underclassmen," by Professors W. A. Hildebrand and S. B. Charters, Jr.

Paper: "Electrical Engineering Instruction," by Professor E. B. Paine.

Paper: "All-year Session, Individual Instruction: Renewed Suggestions," by Dean W. G. Raymond.

Address: "Technical Training from the Business Man's Standpoint," by Mr. E. B. Raymond, Vice-president, The Pittsburg Glass Co.

Paper: "Adapting Technical Graduates to the Industries," by Messrs. C. F. Scott and C. R. Dooley.

Paper: "The Co-operative System of Education at the University of Pittsburg," by Dean F. L. Bishop.

Thursday afternoon will be devoted to visits of inspection, including one to the Westinghouse Electric and Manufacturing Co., at East Pittsburg.

On Friday morning arrangement will be made so that those who wish to stay over will have an opportunity to visit other industries than can be visited on Wednesday and Thursday afternoons.

The local committee plans a series of entertainments for the ladies who will be in attendance at the convention. Among these is an automobile ride about the city and a visit to the Heinz factory where a luncheon will be served. The committee has arranged for a special opportunity for all members and their friends to visit the fine International Exhibition of Paintings at the Carnegie Institute. This exhibition closes before the convention, but the director has agreed to hold the exhibition over for the benefit of our members.

It is possible that an opportunity may be afforded for the members to hear the great organ of the Carnegie Institute, although as the music season closes several weeks before the convention this may not prove practicable.

WELCOME TO PITTSBURG.

MAY 19, 1911.

The Trustees and Faculty of the Carnegie Technical Schools extend to the members of the Society for the Promotion of Engineering Education a cordial welcome to Pittsburg.

Our Institution is peculiarly interested in the object for which this Society stands and we look forward with intense interest to opening our halls for the inspection of your membership. We trust you may find it possible to give us some kindly criticism and advice at this time when we are about to extend our buildings and increase our enrollment until there are registered three thousand students.

Our Faculty will be particularly interested in your papers and deliberations and I trust may find it possible to discuss certain phases of these educational questions with you during your meetings.

Your local committee has enlisted the interest and support of the business, industrial and educational interests of Pittsburg and I am confident your convention here will prove both pleasant and profitable.

ARTHUR ARTON HAMERSCHLAG,
Director, Carnegie Technical Schools,
Pittsburg, Penna.

REPORT OF THE JOINT COMMITTEE ON ENGINEERING EDUCATION.

Professor D. C. Jackson was requested by Mr. Desmond Fitzgerald to send a note by way of a report of progress of the Committee. This he has done as follows:

The Committee has had under way considerable investigation, but has not yet obtained any results on account of the difficulty of obtaining correct statistics of curricula of the engineering schools.

Director, Carnegie Technical School,

It was thought desirable by the sub-committee of the joint committee to first gather together statistics which would show the work that is now being accomplished by the engineering schools. For this purpose, the Carnegie Foundation gathered together many statistics of the important engineering courses of a large number of engineering schools. These statistics were gathered from catalogues and other sources of information in the hands of the foundation. After they were gathered and correlated it was found that the statistics were not accurate, apparently due to the varied bases on which the engineering schools draw up their statements of curricula. The committee then employed an instructor in Columbia University, recommended by the Carnegie Foundation, to make a new collection and correlation of statistics. The data were obtained from catalogues and by means of correspondence with the colleges, but the statistics again proved to be quite inaccurate and incomparative and therefore, had to be abandoned. The committee has now selected twenty of the leading engineering schools of the country, and is undertaking to obtain statistics of one course only (namely the civil engineering course) by direct correspondence with each of the twenty schools, for the purpose of endeavoring to get accurate statistics which will be of a comparative nature; so that conclusions can be drawn in regard to the relative characters of the various curricula, and particularly in regard to their similarities and dissimilarities. In case this proves to be successful, the committee will proceed with an effort to get similar statistics for other engineering courses from the various schools and later will attempt to inquire into the accomplishments effected by the engineering schools.

As yet, the committee has been unable to come to any conclusive results, and no report is yet ready. Probably none will be ready for a considerable period; but the sub-committee of the joint committee have gone far enough to feel convinced that an effort ought to be made to get the engineering schools to put their catalogues, statements and arrangements of curricula upon a comparative basis, so that their differences and similarities may be reasonably well understood.

THE EFFICIENCY OF THE TECHNICAL GRADUATE.

Mr. Kent has forwarded to the secretary a set of questions which formed the basis of a discussion at a recent meeting of the Technology Club of Syracuse, N. Y. The questions are reprinted in the hope that they will be suggestive of suitable topics for discussion in other meetings.

1. What are principal deficiencies of the technical graduate?
2. For which of these is the college directly responsible?
3. Can these deficiencies be avoided by a proper arrangement of the college curriculum or can they be overcome only by experience in commercial work?
4. Does a lack of practical knowledge often prove a bar to the advancement of a technical graduate?
5. What training can the engineer obtain in college which he cannot easily obtain in practice or easily get for himself in spare moments?
6. Does the value of a college training lie more in: (*a*) The knowledge acquired? (*b*) The mathematical training? (*c*) The so-called practical information gained? (*d*) The skill acquired in analyzing problems of all kinds and reasoning about them? (*e*) The general association with students and faculty? (*f*) The social standing gained?
7. What is the value of college shop training? Is it more valuable as a means of discipline, for the practical skill acquired or the general knowledge of machinery obtained?
8. We sometimes hear the charge that college courses are too theoretical. Is there an advantage in attempting to make them practical by imitating commercial conditions?
9. Is it advisable to lay out a technical course with the view of keeping the men at work, say ten hours a day, or is it better to give them time for reading magazines and books other than those used as texts?
10. The M. I. T. is laying more and more stress on cultural subjects like the languages, economics and history, and is avoiding narrow specialization by undergraduates. Is this a move in the right direction?
11. Has a technical graduate any real advantage over a liberal art man in engineering? In commercial work generally?
12. Judge Gary has said that his company will hire no more technical graduates unless they have also had a liberal art training, because otherwise, the men are too narrow to warrant their advancement to the higher positions. Is he right?
13. Is it not a fact that most technical students enter college too young and are not mature enough for the work? Would it not be better to require them to have a liberal art degree before entering or to arrange the courses so that they might take both a liberal art and technical course in six years?

IMPROVEMENT OF LABORATORY INSTRUCTION.*

BY PROFESSOR E. J. KUNZE.

While connected with the instructional staff of the University of Wisconsin the speaker, realizing that the laboratory can be best operated along business lines, proposed for the steam and gas engineering laboratory the adoption of the preliminary report, of the instrument checking system, and of a bulletin board which shall contain the assignment of all of the experiments for the semester, with a means for indicating to both student and instructor the condition of reports on these experiments. With the exception of the instrument checking system which has not yet been brought to a working condition, these have been found to work out in a satisfactory manner. As originally suggested a man would be required to remain in the instrument room and check out and receive apparatus, while experiments were being performed. In the system here proposed such is not the case.

To make the system complete the speaker would propose the preliminary report, which afterward should form a part of the final report, to prepare the student for his experiment and hence conserve the time spent in the laboratory in preparing for the experiment, this report to contain a statement of the object and general method of making the experiment, with a statement of the instruments required. The instrument room should be closed to students and furnished with compartments in which may be kept boxes, each of which will contain all of the instruments required on the experiment indicated on the label attached to the box. A bulletin board indicating the experiments to be worked by each student at each period, also designating which student should have charge of the test,

* This contribution from Professor Kunze was submitted as part of the discussion of efficiency at the Madison meeting. It was inadvertently omitted from the PROCEEDINGS.

should be conveniently located in the laboratory. This method was very successfully operated during the semester just past by the use of the bulletin board which may be still found hanging in the laboratory. It was laid out by the speaker according to the following scheme:

Experiment.	John Doe.	Richard Doe.
Calorimeters	5–7	5–7
	√	√ √
Slide Valve Setting	*5–14	5–14
Simple Engine Test	5–21	*5–21

In explanation, as indicated, the experiment on the slide valve setting was due to be performed on May 14, the preliminary report on this experiment was due on the seventh, and the final report on the twenty-first. A single check indicates that the report was received but lacks something that requires the student to consult his instructor. A double check indicates that the report is accepted. The assignment of the one who is to have charge of the test, which is indicated by a *, has the influence of cultivating a feeling of responsibility on the part of the student.

At the time of the test the writer has been in the habit of running over the different things to be done and the methods of doing them with the squad assigned to the experiment, in order that all may have in perspective all that is to be done. The student in charge draws out of the instrument room the box containing all of the instruments required on the test. He is then handed a sheet which contains all the necessary data concerning the experiment, such as the diameter of the cylinder, etc. It also contains a list of the different observations to be taken, and so arranged that they may be quickly assigned to different men by the one in charge who at the same time hands each man the instrument proper for his duty. During the test he records data which are afterwards called off to the other members of the squad. He also gives the signal

for the taking of readings. As a further development of this system the speaker would suggest the construction of lockers, keys of which are to be given to the men in the squad by their foreman, who shall turn in to the instructors the names of the men and the corresponding numbers of the keys given so that after the test has been performed the instructor may, at leisure, examine all instruments used before returning them to the compartment assigned for that particular test. This system also permits of locating the responsibility for any error such as, for instance, may occur in integrating indicator cards.

In the work here the necessity of a regular class room course in connection with the laboratory work was largely avoided by Professor Thorkelson, who worked out a system of correlation with courses now existent. The speaker believes, however, that it is always well to indicate the different methods used of obtained data, etc., explaining the advantages and disadvantages of each. This can best be done in the laboratory, and may be done before each experiment as indicated before, unless more than two sections are working on different large experiments at the same time, in which case it would be best to arrange for class room periods.

Much unnecessary labor can be saved by having such things as continuous counters, scales, etc., permanently attached to engines during the period in which tests on those engines are being performed. Of course means should be employed for disengaging such apparatus while not required for the taking of observations.

The adoption of computation periods for working up tests, eliminates the evil of having one or two men on a squad do most of the work in computating. It also prevents the student from losing interest because of meeting some obstacle, since he would have some one to help him over the high points.

The speaker fully realizes that no system will exactly fit all conditions, but he feels that with some system such as that just described, the laboratory work may be made more smooth and much time and energy saved.

EDWARD J. KUNZE.

MADISON, WIS.,
June 24, 1910.

COLLEGE NEWS.

University of California.—A recent number of the *Alumni Weekly* contains a brief history of the Civil Engineering Department. The following quotation indicates the spirit of the department.

"The College of Civil Engineering aims to present its special fields of study with the broadest viewpoint. It emphasizes schedules which specialize in structural engineering, sanitary engineering, railway work and irrigation. But these four groups of specific engineering aims are not more important to the students than the earlier preparatory basic subjects—mathematics, physics, chemistry, drawings, the languages, history and economics. The ambition of the college is to increase gradually and logically the requirements for matriculation and graduation. The tendency is to elongate the course in time and to require students to show fitness in varied branches of knowledge. This is the object in all of our engineering colleges. We want broad men.. The typical, successful and ideal engineer of the future must blend the abilities of contractor, economist, business man, scholar and gentleman.—During 1911 extensions are to be made to our testing and sanitary laboratories, which will triple the floor space available to those interests.—For the current decade the future of the Civil Engineering College looks bright. We intend to keep pace with the rest of our progressive University. We now have a strong undergraduate department and offer substantial design courses of advanced treatment to students who wish to remain a fifth or a sixth year. Ten years hence we expect to enjoy fully the advantages of a broad graduate department built upon firm requirements, nourished by ample laboratory facilities and directed by a numerous and representative faculty of instructors. The field for civil engineering is as wide as the world."

Franklin Union.—Director W. B. Russell recently presented

his third annual report. As will be remembered, this new school is the outcome of a bequest left by Benjamin Franklin to the city of Boston. The following quotation from the report indicates the success which has already been achieved.

"The year has been marked by an attendance which has taxed the present accommodations, and which in January necessitated opening the building for classes on Tuesday evenings, thus making four evenings per week. It is evident that future growth must be met by further extension of the number of hours per week which the plant is used. The registration by years, as shown by the cashier's vouchers, and after deducting the names of those enrolled in more than one class, is as follows: For the first year, five hundred thirty-three; for the second year, eight hundred fourteen, and for the present year, twelve hundred thirty-eight. The total number of different men enrolled since the building was opened is two thousand one hundred ninety-eight. Of this number forty-three have attended continuously for three years, and two hundred eighty have attended for two years. The average age of the men at present registered is twenty-five and three tenths years. Certificates for two-year courses were granted last year to sixty-six men and this year to eighty-six men."

"The plans for next season contemplate the opening of the building for regular classes four evenings per week and Saturdays. All of the present classes will be continued with but slight changes in arrangement. A new class will be added in special electricity starting in September, and also a new class in "Reading Shop Drawings." The latter is intended for machinists, apprentices or helpers, who do not desire a course in mechanical drawing. If a sufficient number of men come from one shop, the work will be specially outlined for them. Franklin Union stands ready at any time to adapt classes to the particular needs of apprentices or others in any industry, or in a single shop. Its aim is to supplement the work of shop men, and for this purpose to conduct classes at any time or in any way that will directly meet the situation. It is hoped that, eventually, more than one manufacturer may be willing to

excuse his younger men and his apprentices for two or three hours per week for late afternoon instruction in classes arranged particularly to supplement their daily work. Experience with Saturday afternoon classes has demonstrated the advantage of an hour of afternoon instruction over one in the evening. It is possible in many lines of employment to make the class instruction of such a practical character that the increased daily efficiency of the students may recompense an employer for the concession of two or three hours per week, without loss of pay. Moreover, with students sixteen years of age or over, instruction of the right kind, if extended for one or two years, even for only a few hours per week, results in an immediate increase in productive capacity and in earning power."

University of Illinois.—On April 7 and 8 there was held, under the auspices of the Department of Electrical Engineering, a conference with central station men, including a series of lectures. The conference was designed especially for the benefit of electrical and operating engineers throughout the state, and it was successful in establishing closer relations between such workers and the Department of Electrical Engineering of the University. The formal part of the program was as follows:

FRIDAY, APRIL 7.

"The College of Engineering and the Engineering Experiment Station." Dean W. F. M. Goss.

"Choice of Prime Movers for Central Stations," Ernst J. Berg.

"Central Station Photometry," J. M. Bryant.

SATURDAY, APRIL 8.

"Resuscitation from Electrical Shocks," Demonstration with and without instruments, R. Y. Williams.

"Effect of Vacuum, Superheat and Steam Pressure on Station Economy," Ernst J. Berg.

"Cost of Street Lighting," J. M. Bryant.

Inspection of University Buildings.

The Railway Engineering Department of the University of Illinois has just completed an interesting series of locomotive tests for the Illinois Central Railroad. The tests were made to determine the relative evaporative efficiency of different kinds of coal. The coal to be tested was burned in the fire-box of a locomotive in the Champaign yards of the railroad, and the steam generated was exhausted through a pipe which took the place of one of the safety-valves. The tender of the locomotive was removed, and in its place was put a platform on which were scales and tanks for the measurement of the amount of coal used and water evaporated. Draft was kept up by allowing some of the steam generated to blow through the steam nozzle, the valves being removed from the steam chests. Some very interesting results were obtained from the tests.

Massachusetts Institute of Technology.—A remarkable Congress of Technology was held in April at the Institute. A program of scientific and technical papers was presented by alumni of the Institute. The opening session of the congress was begun with an address by President Maclaurin who attributed the success of the Institute to the methods of instruction which he said while everywhere now accepted were not long ago a debated and somewhat scorned venture. "Apart from his appreciation of the value of all sound learning," said Dr. Maclaurin, "Wm. Barton Rogers, the founder and first president of the Institute, saw clearly that the whole controversy as to the relative merits of science and the classics in the field of education missed the mark by placing the emphasis in the wrong place. He understood that when one gets to the root of things in education, the *method* rather than the *subject* is of supreme importance, and his insistence on the value of method in teaching was the cardinal doctrine in his creed and the one that has contributed most to the success of the Institute. His fundamental idea here was not original with Rogers. It had been clearly expressed before, but rarely, if ever, adopted definitely as the basis of educational method and applied systematically throughout. The

idea is familiar to us all today, the idea of *learning by doing.*"

The practical earnestness of the alumni in doing their full share toward making possible the "New Technology" was shown in three announcements made by President Maclaurin from the platform after the banquet held on Tuesday evening. One alumnus, who wished his name withheld, has offered to the Institute a tract of 1,000 acres of land in Maine, well suited to the uses of a summer school in civil engineering. Other alumni have definitely pledged themselves to give a very large part of the price necessary for buying a new site for the Institute. Edward M. Hagar, Tech. '93, president of the Universal Portland Cement Co., has promised as a gift all the cement needed for erecting the new buildings in reinforced concrete. Meanwhile, the question of the site itself, Dr. Maclaurin said, had been narrowed to a choice between three sites all of which are within a short distance of the present buildings. It is expected that this question of a new site, upon which everything else on the development of the Institute depends, will very soon be settled.

University of Minnesota.—The many friends of Professor A. E. Haynes will be gratified to learn that, after some time spent in California this winter, he is again in good health and will resume his regular college work in the fall. If his friends had not advised to the contrary Professor Haynes would have been on hand at the Pittsburg meeting, but it seems wise for him to rest as much as possible in order to fully conserve the results of the year's rest.

University of Missouri School of Mines (Rolla, Mo.).—The School has received an appropriation from the Missouri Legislature for the erection of a fire-proof library and assembly hall, for the completion of the ore dressing building, and for power plant improvements. The annual commencement exercises of the school were held on May 26. The address to the graduating class was delivered by Dr. J. A. Holmes, director of the Bureau of Mines, Washington, D. C., his topic being "The Individual, the State, and the Nation in the Development of our Mineral Resources."

New York University.—On May 5 the University celebrated the one hundredth anniversary of the birth of John William Draper, one of the foremost scientists that America has produced, whose fundamental discoveries and inventions have been of untold benefit to mankind. Professor A. B. Lamb has prepared an outline from which the following extracts are made: Dr. Draper's most notable achievement, perhaps, was his improvement of the then novel photographic process of Daguerre, whereby he won the historic distinction of being the first to photograph the human features. Draper was also actively engaged with Professor Morse in his production of the telegraph. The series of experiments made by Professor Draper in the laboratory of the New York University established for the first time with certainty, the practicability of sending messages over long distances. The instruments used in these experiments are still preserved in the Museum of the University.

Another important discovery which science owes to Draper is his explanation of how blood is purified in our lungs, a process until then shrouded in mystery. By simple, but classic, experiments with thin films of solid material and with soap bubbles he showed that gases pass freely through thin partitions of many substances, until the pressure of each gas reaches equality on either side. He showed that in breathing, the oxygen of the air passes through the thin walls of the blood vessels in the lungs and is then absorbed by the blood, while the waste gas, known as carbon dioxide, which is dissolved in the blood, passes outward in a similar fashion into the air tubes. His elucidation of this process is the cardinal fact in modern physiology.

He was the first to discover that in the ultra-violet part of the solar spectrum there are absorption bands similar to the Fraunhofer lines of the visible spectrum. He studied the chemical effects of the different portions of the spectrum, the distribution of heat in the diffraction spectrum, the action of light on the growth of plants, and made many other researches. He suggested, as a standard of photometry for white light, a piece of platinum foil of given area and thick-

ness, heated to incandescence by an electric current of specified strength, thus, in fact, anticipating the incandescent electric lamp of Edison, and in a general way proposed many photometric standards of later date. Kirchhoff and Bunsen have been generally credited with the discovery of spectrum analysis, but thirteen years before the announcement of their discovery Draper had clearly enunciated the fundamental principles on which spectrum analysis depends. He reached the conclusion that the occurrence of lines, whether bright or dark, in the spectrum of burning and incandescent substances is connected with the chemical nature of the substances producing the light. "If we are ever able," he said, "to acquire certain knowledge respecting the physical state of the sun and the other stars, it will be by an examination of the light they emit." In a memorial address on Draper, Professor George F. Barker states, "that surely these researches, with the prophetic conclusions he drew from them, entitle Professor Draper to a recognized position among the pioneers in the science of prismatic analysis."

Ohio State University.—The April Bulletin of the University contains the itinerary of the western inspection trip of the departments of mechanical and electrical engineering. The trip this year was taken to Chicago, the engineering features of which were very carefully studied. The trip began on Sunday, April 23, and ended Sunday, April 30.

University of Utah, School of Mines.—Director Joseph F. Merrill calls attention to a feature of the organization of the University which is not clear from the table published in Volume XVIII. of the PROCEEDINGS. He states that the Utah State School of Mines is the engineering department of the University of Utah, located on the same grounds and under the same management as the University. It has, perhaps, the same relation to the University that Sibley College has to Cornell University. The present members of the Society in this institution, as well as those now joining, are all engaged, to a greater or less extent, in teaching engineering students and can very properly listed as School of Mines, University of Utah.

A paper to be presented at the nineteenth Annual Meeting of the Society at Pittsburgh, Pa., June 27, 28 and 29, 1911. Discussion is invited. Communications may be addressed to the author or the Secretary.

BALANCE OF COURSES IN CHEMICAL ENGINEERING.

BY CHARLES H. BENJAMIN,

Dean of the Schools of Engineering, Purdue University.

INTRODUCTION.

Chemical Engineering as a distinct profession is growing and its development, although steady, is slow. The pressure for the introduction of separate courses in this branch of engineering has come from without rather than from within. Professors, whether of chemistry or of engineering, have been inclined to look askance on this newcomer as the offspring of an unholy alliance, but the growing demand for men who possess a working knowledge of both professions is gradually reconciling them to the new arrangement.

In studying the development of chemical engineering, we have but to hark back twenty years and read the description in college catalogs of the courses in electrical engineering as they then existed.

The increasing use of electricity in the production of light, heat and power and in telephone service brought with it a demand for men who combined engineering training with a knowledge of the new agent. This demand received at first a half-hearted consideration from the faculties of our engineering schools. Perhaps the professor of physics took charge of the new department, bought a dynamo or two and grafted a little engineering on the science course. More frequently the professor of mechanical engineering assumed a double title and brushed up his knowledge of volts and amperes.

Gradually the warring elements were brought into harmonious relations, the useful was retained, the useless dropped, and under the administration of an electrical engineer, the course attained the place and the dignity which it deserved.

In a somewhat similar way, new enterprises and new combi-

nations are seeking for men who have both chemistry and engineering, and these men will be called in the future "chemical engineers."

The professor of chemistry and the professor of mechanical engineering are just now a trifle at sea as to the parentage of this last addition to the college family, but we have a right to infer from past history that their differences will be adjusted, that the right balance will be established and that under the leadership of a chemical engineer, the new course will take its rightful place among its brethren.

Definition.

The chemical engineer may perhaps be described as a man who is competent to so superintend a manufacturing plant as to insure both the chemical purity of the product and economy in the mechanical operation of the factory. As a natural result of conservation and concentration, establishments are now built and equipped for the manufacture on a large scale of various products used in the arts, which were formerly made in smaller quantities at a much greater unit cost. Paints and oils, varnishes, acids, petroleum products, soap, sugar, starch, glass, pottery, explosives, paper, cement, bleaching powders, nitrates,—are examples of products requiring for their economical manufacture, knowledge of both mechanical and chemical processes.

Some companies have attempted to solve the problem by employing two men, an engineer and a chemist, and trusting to their joint efforts. At its best, dual control is unsatisfactory and inefficient, leading to divergence and misunderstanding. The one man should rule and he should be capable of meeting all problems that arise, whether chemical or mechanical.

How Taught.

There have been and still are marked differences of opinion among educators as to the methods of teaching chemical engineers and as to the relative amounts of engineering and chemistry to be put in the curriculum. Naturally, when the de-

partment has been an outgrowth or development of the course in chemistry, that science has received the more attention. In other colleges, the addition of more chemistry to the course in mechanical engineering has left the greater weight on the engineering side.

TABLE I.

CHEMICAL ENGINEERING. ACTUAL HOURS PER WEEK.

	Michigan.		Massachusetts.		Purdue.		Wisconsin.	
	Rec.	Lab.	Rec.	Lab.	Rec.	Lab.	Rec.	Lab.
English	4	.....	8	.....	9	.....	6	.....
Language	16	.....	8	.....	16	.....	8	.....
Economics	.....	.....	8	.....	6	.....	.....	.....
Letters	20	.....	24	.....	31	.....	14	.....
Mathematics	18	.....	14	.....	22	.....	19	.....
Physics	8	6	11	6	9	4	8	8
General science	.....	.....	.....	.....	.....	4	.....	.....
Science	26	6	25	6	31	8	27	8
Drawing	.....	12	.....	32	.....	24	.....	18
Shop	.....	12	.....	2	.....	12	.....	10
Mechanics	4	.....	8	.....	8	2	13	.....
Mechanical engineering	4	6	9	2	8	3	8	19
Electrical engineering	2	6	2	3	6	6	4	8
Civil engineering	2	6	.....	.....	.....	.....	.....	.....
Engineering	12	42	19	39	22	47	25	55
General chemistry	4	.....	7	8	4	6	4	8
Qualitative analysis	4	12	.....	8	4	12	2	8
Quantitative analysis	4	18	.....	21	4	12	2	8
Organic chemistry	5	.....	7	11	4	12	4	12
Industrial chemistry	12	21	6	12	8	24	11	18
Inorganic chemistry	.....	.....	2	.....	.....	.....	.....	.....
Theoretical chemistry	.....	.....	6	6	.....	.....	.....	.....
Chemistry	29	51	28	66	24	66	23	54
Electives theses	5	12	.....	.....	.....	.....	4	24
Totals	92	111	96	111	108	121	93	141

The accompanying tables and diagrams show the distribution of work by hours in the chemical engineering courses of eight representative institutions. These figures were originally compiled from catalogues and in all cases but one were referred to the professors in the various colleges for correc-

TABLE II.

CHEMICAL ENGINEERING. ACTUAL HOURS PER WEEK.

	Illinois.		Pennsylvania State.		University of Pennsylvania.		Columbia.	
	Rec.	Lab.	Rec.	Lab.	Rec.	Lab.	Rec.	Lab.
English	6	.....	13	.....	9			
Language	8	.....	15	.....	12			
Economics	6	.....	14	.....	3			
Letters	20	.....	42	.....	24			
Mathematics	15	.....	20	.....	18	.....	15	.....
Physics	4	10	7	4	7	4	12	.....
General science	4	6	.....	.....	2	.....	.....	6
Science	23	16	27	4	27	4	27	6
Drawing	.....	.....	2	17	.....	12	4	20
Shop	.....	.....	.....	7	.....	12	.....	7
Mechanics	8	3	7	4	17	.....	12	6
Mechanical engineering	3	6	12	.....	19	6	19	12
Electrical engineering	.....	.....	6	15	9	12	4	3
Civil engineering	.....	.....	.....	.....	.....	.....	2	10
Engineering	11	9	27	43	45	42	41	58
General chemistry	5	8	6.5	5	6	12	6	.....
Qualitative analysis	1	7	.....	7.5	10	18	4	13
Quantitative analysis	4	20	2	16.5	12	18	8	24
Organic chemistry	6	12	2	.....	8	20	10	18
Industrial chemistry	14	30	11	36	7	17	38	22
Inorganic chemistry	.....	.....	.....	.....	.....	.....		
Theoretical chemistry	.....	.....	.....	.....	2	6		
Chemistry	30	77	21.5	65	45	91	66	77
Elective theses	2	4						
Totals	86	106	117.5	112	141	137	134	141

tion. They probably represent closely enough for our purpose the relative times assigned to the different branches.

For convenience of comparison, the subjects have been arranged in four groups: (1) Letters, comprising all language work, economics and history; (2) science, embracing mathematics, physics and geology; (3) engineering, covering all technical subjects not chemical in character; (4) chemistry, embracing all chemical subjects whether theoretical or technical.

The exact arrangement and definition of subjects in the chemical group is probably not always correct but as the comparison is to be made by groups, this is not important.

The tables show the actual or clock-hours per week for the entire course added together.

Diagram 1 represents the times of the various groups graphically, the upper line in each case being class room work and the lower line laboratory, shop or drafting room time.

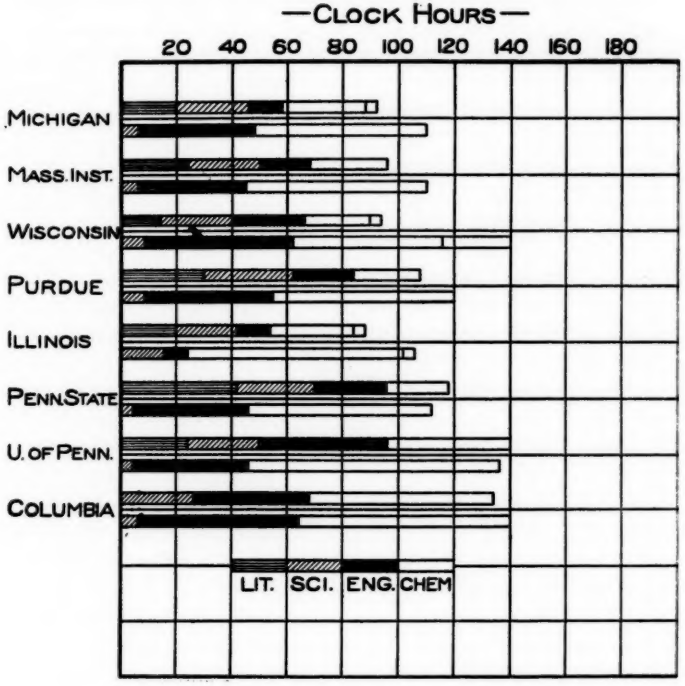

DIAGRAM 1.

In Diagram 2, the two sets of hours have been added by reducing to credit hours. Each class room hour is rated as one credit hour and two and one-half laboratory hours are

allowed the same weight. This is the ratio obtaining at Purdue University and is about an average of those in common use.

Whenever the hours of chemistry are divided in two parts, the right hand portion represents elective work and is not necessarily chemistry.

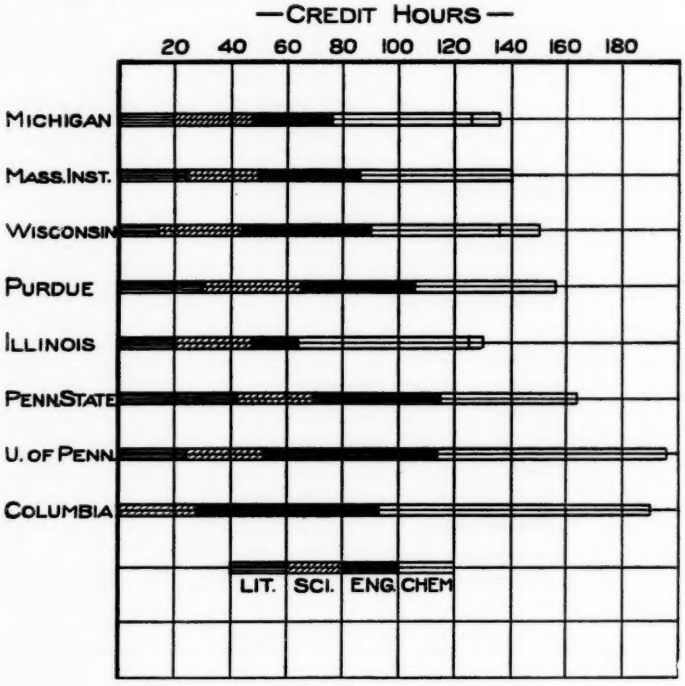

DIAGRAM 2.

In Diagram 2, the first four lines represent the courses at present in the Massachusetts Institute of Technology and in the universities of Michigan, Wisconsin and Purdue. These are somewhat similar in the balance of subjects and perhaps represent a happy mean. The percentages of total time are as follows:

TABLE III.

	Letters.	Science.	Engineering.	Chemistry.
Michigan	14.7	20.6	21.3	43.4
Massachusetts Institute	17.1	19.3	25.0	38.6
Wisconsin	9.4	20.0	31.3	39.3
Purdue	19.9	21.8	26.2	32.1
Average	15.3	20.4	25.9	38.4
Or, in round numbers,	15	20	25	40 %

The courses represented by the last four lines in Diagram 2 can not be so easily arranged. Not only do the totals differ considerably but the percentages of subjects vary widely.

TABLE IV.

	Letters.	Science.	Engineering.	Chemistry.
Illinois	15.5	22.5	11.6	50.4
Pennsylvania State	25.8	17.8	27.0	29.4
University of Pennsylvania	12.3	14.8	31.8	41.0
Columbia		15.3	33.6	51.1

Examining the tables and diagrams somewhat in detail, we find that Michigan differs from the other three in Table III. by having less engineering, and reference to Table I. shows this deficiency to be due to a relatively light class room schedule in mechanics and mechanical engineering. Wisconsin is noticeable for the small amount of time in letters. A few hours taken from engineering and added to letters would restore the balance.

Illinois has relatively less engineering and more chemistry than the other institutions, while the total number of hours is less than the average. Reference to Table II. shows this to be due to the almost entire absence of mechanical and electrical engineering.

The course at Pennsylvania State College is marked by a relatively large amount of letters and a small amount of chemistry, in other words, the course is broader and less technical than the others.

The two last institutions on the list, Pennsylvania and Columbia, have apparently much heavier schedules than is

usual, averaging thirty-three per cent. greater than the 145 hours which represents the mean weight of the courses in Table I.

Comparisons of total weight are, however, somewhat uncertain, owing to the different ratios used in determining credit hours at the various institutions.

A peculiarity of the course at Columbia is the omission of all work in language or economics, the schedule being entirely of a technical character. The wisdom of this is doubtful. It is but fair to say that a collegiate preparation is recommended and that the regular requirements for admission to the school include considerable language and history.

In institutions for the Middle West, it is necessary for a well-balanced education that literary training should form a considerable part of the technical courses.

Cornell, Worcester and Minnesota have not been included in the list. At Cornell there is no course in chemical engineering as such. A special course in chemistry allows the student to take a small amount of engineering work, amounting to about 20 credit hours for the entire course. Similarly, students in mechanical engineering may take certain electives in chemistry covering 10 or 12 credit hours.

At Worcester, a fifth year, leading to the degree of chemical engineer is added to the regular course in chemistry and is made up almost entirely of mechanical and electrical engineering subjects.

At Minnesota there is a five-year course in applied chemistry.

The work at the three institutions last named can not consistently be compared with the four-year courses shown in the tables.

ADMINISTRATION.

The location and administration of courses in chemical engineering vary so widely that no general statement can be formulated as may be seen by reference to Table V.

The tendency seems to be to regard this course as belonging with the engineering courses in the school or college of engi-

TABLE V.

Institution.	Course in Chemical Engineering.	
	School or College.	Administrator.
Michigan	Engineering.	Professor of chemical engineering.
Massachusetts Institute	Chemistry.	Professor of chemistry.
Wisconsin	Engineering.	Professor of applied electro-chemistry.
Purdue	Engineering.	Professor of chemistry.
Illinois	Science.	Professor of chemistry.
Pennsylvania State	Natural science.	Professor of chemistry.
University of Pennsylvania	Engineering.	Professor of chemistry.
Columbia	Mines, engineering and chemistry.	Professor of industrial chemistry.

neering. On the other hand, it is usually administered by a chemist. At Michigan, Wisconsin and Columbia he is to all intents and purposes a chemical engineer, if we may judge by his title.

Conclusions.

The chemical engineer occupies a different field from that of the analytical chemist and requires a different training. The analytical chemist, as employed for instance, in the manufacture of iron and steel, is usually a subordinate; he examines the product and determines its good or bad characteristics but has little or nothing to do with the management of the business or the superintendence of the processes of manufacture.

On the other hand, the chemical engineer in a cement or an acid factory may well be the superintendent or works manager and must be competent to direct the mechanical as well as the chemical processes of manufacture, to buy and maintain machinery and to hire and discharge men. He must then have a fair engineering training in addition to a working knowledge of technical or industrial chemistry. His course in college must not be narrow but broad and general and it is better that the course be administered by a chemical engineer, one who is entirely competent himself to fill the positions for which he is trying to fit the student.

No attempt has been made in this paper to discuss the

technical details of the work either in chemistry or engineering. Perhaps some difference of opinion may exist as to the proper place of subjects such as electro-chemistry, but in this analysis everything has been credited to chemistry which involves chemical knowledge and manipulation.

As most of the material herein used has been taken from current catalogs, some mistakes may have occurred, but it is believed that the relative proportions have been preserved. It is hoped that attention may be called to any mis-statements or inaccuracies as the sole purpose of the paper is to bring out facts as a basis for discussion.

A paper to be presented at the nineteenth Annual Meeting of the Society at Pittsburgh, Pa., June 27, 28 and 29, 1911. Discussion is invited. Communications may be addressed to the authors or the Secretary.

AN ENGINEERING COURSE FOR UNDERCLASSMEN.

BY W. A. HILLEBRAND AND S. B. CHARTERS, JR.,

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It is standard practice in American technical schools today to confine instruction in electrical engineering to the last two years of the course. This custom, backed as it may be by good and sufficient reason, has for the student who enters college with the intention of becoming an electrical engineer, two serious drawbacks.

In the first place, the young man must wait two years at least before learning anything about that which he has determined shall be his life work, and three years or more elapse before he is able to judge, even from what experience college can give him, whether his choice was a wise one. Whatever enthusiasm he may bring with him as a freshman often suffers from the severe regimen of science and mathematics on the one hand and an intense social life on the other, through which he wanders with more or less purpose according to the dictates of temperament, previous training and immediate environment.

A second disadvantage lies in the fact that the faculty in electrical engineering, the men with whom he will be most intimately associated during his college course, who will have his welfare more closely at heart, who will feel their responsibility toward him more deeply, who will have the greater interest in his ultimate success, and who should, therefore, have the greatest influence over him, do not make his acquaintance until his college career is often more than half over. Valuable time is thereby lost in gaining headway, before the personality of this portion of teaching staff can exert its proper influence.

With these ideas in mind, a course, conducted by the faculty

of electrical engineering, was this year instituted at Stanford University for the freshmen who register in that department.

Our purpose was primarily to get acquainted with the first-year men, their needs, and, if possible their aspirations, and in return to stimulate in them a professional interest based on a study or contemplation of concrete engineering achievement. We have also attempted to give them an idea of the real conditions of industrial life and to make them understand why they came to college, what the college may be expected to do for them, and above all else what it cannot possibly do. In pursuit of this ambitious purpose, with but one hour at our disposal, the following program was adopted.

As a preliminary, answers were required from each man to the following set of questions. A summary of the replies with some of the conclusions drawn therefrom will be given later.

GENERAL INFORMATION FOR DEPARTMENT.

1. Age?
2. From what town do you register?
3. Father's occupation?
4. Are you self-supporting, wholly or in part?
5. Have you ever worked at any gainful occupation of any kind? If so, enumerate the various kinds of employment and state about how long, all told, you were occupied at each.
6. Where did you go to school?
7. What were the principal courses studied?
8. In what things of life, of any sort, are you particularly interested?
9. Have you studied electricity and magnetism in physics?
10. What is your idea of the duties of an electrical engineer?
11. Is there any particular line of work toward which you are looking after graduation and for which you expect the college to fit you?
12. Name all the distinct branches of electrical engineering that you can think of.
13. Does any one of these appeal to you more than another? If so, name it and tell why.

14. What is your reason for coming to Stanford rather than to another college?

15. What is your conception of the purpose of an engineering education?

16. About what proportion of your college work will be devoted to the study of purely electrical subjects and why?

17. What has question 16 to do with your life work?

The course itself, entitled "A Survey of Electrical Industries," is divided into two parts, lectures, occurring every two weeks, and interviews once a month with each student, covering assigned reading. In addition thereto a written report is required on each lecture. The three members of the faculty co-operate in the work of instruction, each giving the lectures appropriate to his particular field and having one third of the class report to him for the monthly interview. One hour credit per semester is allowed.

In assigning topics for outside reading each student was asked to signify some branch of engineering activity about which he had a curiosity to know more, and was then referred to appropriate articles in the periodical literature. The idea was to stimulate his interest by giving him something concrete, definite, from which general principles might be derived if need be. A constant effort was made to impress each individual with the fact that much useful and valuable knowledge may be acquired without waiting until the middle of the senior year, provided he will use his initiative and avail himself of the opportunity presented.

A provisional schedule of lectures covering about three semesters is submitted herewith:

1. Power sources, engines, turbines, gas engines.
2. Water wheels.
3. Dynamos, motors, et cetera.
4. Markets, transmissions and distributions.
5. Transmission network.
6. Electric street railways.
7. Electric lights.
8. Telephones.

9. Telegraphs.
10. Lighting.
11. Wireless transmission.
12. Electrochemistry.
13. Electric furnaces.
14. Railways.
15. Industrial power.
16. Lighting sources.
17. Illumination, photometry, and principles thereof.
18. High tension networks.
19. Trend of progress.
20. Ditto.
21. Ditto.
22. Historical.
23. Biographical.
24. Societies and Bureau of Standards.

They are strictly "informational," intended to give some understanding of the various applications of electricity to the uses of everyday life. The first part of the year, however, was devoted to the following topics: reasons for coming to college, and what may be expected from a college course; the standard four-year course for electrical engineers, covering the reasons why the various subjects occupy the places they do and the importance of mathematics as prerequisite for the more advanced subjects; the importance and value of a careful use of English; the education of a broad-minded citizen; professional ethics.

So much by way of explanation. Now, what of the results after six months of operation?

A summary of the replies to the more important questions submitted develops the following facts:

Number of replies: 25.

Average age: nearly twenty years.

Geographical distribution: from the eleven Pacific Coast states, 19; from Rocky Mountain states and west thereof, 22; scattering, Missouri, Kentucky, Michigan, 3.

Number self-supporting: wholly, 4; in part, 5.

Employment: Twenty-one have worked at some gainful occupation; average of total time, per man employed, 17 months; average for class, 14 months.

Home environment: The fathers of nine of the men are engaged in occupations that may in any way be described as mechanical. These are: locomotive engineer, mining engineers (2), manufacturers (2), sheet metal workers, manager of telephone and hydro-electric companies (one each), contractor and builder. The other occupations run: real estate dealer, teacher, farmer, grocer, banker, mariner, barber, judge and lumberman. The largest single group are farmers.

The replies to question ten show almost without exception that to these freshmen an electrical engineer is a man directly associated with the design, construction or operation of electrical machinery. Of the great co-operative enterprise for accomplishing results, of which engineering from their narrow viewpoint is but a tool, or of the various economic factors with which their lives will be largely taken up, they have no conception. This is, perhaps, only natural, but a point of view which it is none the less important for the teacher to ascertain.

Concerning the magnitude of salaries commonly paid to men in the profession there is also an exaggerated belief. For instance, two of the men who reported to the author, after reading Damon's article on the "Opportunities in the Electrical Business," were very much disturbed in mind as to whether they had made the proper choice of a vocation.

Another conclusion to which we have come through our acquaintance with these young men, is that most of them firmly believe the possession of an engineering degree will of itself place the holder on the road to success and a large salary, and that at a date not very remote from graduation. They are only too ready to admit that for the first few years it will be hard work with low pay, but are firmly convinced that, once embarked upon the road, industry will bring its full reward.

Taken in connection with the geographical distribution of our students, a careful analysis of the replies to question four-

teen convinces us that if a man selects his college or university because of popular impression or from what he is able to learn of the excellence of its course in electrical engineering, he goes to any place but Stanford. Most of our men frankly said they came to this university because it is "near." That is, we draw from among a restricted clientele students who come to college because the opportunity is offered, and who take electrical engineering because, of various ways of earning a living, they think that will be both congenial and profitable. This is not intended in any way as a reflection upon our student body, who will average as high as the students at any other institution, but it does mean that any institution which expects to meet efficiently its particular problem must begin by squarely facing the underlying facts. For instance, under conditions such as these, are the responsibilities of the teaching staff the same or would the same type of instruction be offered as would be the case if every student spent his undergraduate days at several different universities, taking from each the best it had to offer in his line?

What has been said about Stanford in regard to the geographical distribution of its students will be found true of most of the universities of this country, in spite of a possibly wider reputation.

The reaction of such a group of students to the course we are attempting to give is about what might have been expected. Especially is this true of their attitude toward that portion designed to stimulate initiative and independent observation. To most of them it makes no appeal and is handled like any other prescribed subject, with results that are a distinct disappointment. This attitude of mind, mental lethargy, if you will, pervades all classes of our students, to such an extent, for instance, that we have been unable to interest even the seniors in the meetings of the San Francisco section of the American Institute of Electrical Engineers, a journey of thirty-five miles and some small expense being unable to compete with the social possibilities of Friday night.

The necessity of combating such a spirit was the prime

reason for instituting this course, in the hope that by starting early enough and applying the pressure throughout four years instead of a year and a half, results might be achieved. Out of the twenty-five men there stand perhaps five alert, ambitious lads, whose reaction is in every way satisfactory and who will, by their senior year, rise head and shoulders above their comrades. Through the potent influence of such men over their fellows we hope, in the course of years, to develop a greater appreciation of the necessity for each man doing more for himself during his college course than is required for graduation.

It is interesting to note that these same men were the first to respond to our urgent admonition to do shop or field work during at least a part of the summer vacation.

Upon the faculty in electrical engineering our acquaintance with these freshmen has had a profound influence, chiefly in revealing to us more clearly the broader aspect of our problem, wider responsibilities toward the students who come to us from a world hypnotized by the magic of mechanical achievement, and the possibilities that arise through a more intimate contact with our men through a period of four years instead of one and a half or two. For example, one of our most indifferent students wants to be an electrical engineer simply because, having clerked in a store, a distasteful occupation, and possessing no taste for the humanities, he sees no other course open to him. We consider it a distinct advantage to have "spotted" such a man in his freshman year, for there are not a few of his kind who escape the dragnet of calculus and descriptive geometry.

An interesting side light, but of vital significance to the educator, is the fact, which we discovered with quite a shock, that these freshmen are in many respects quite as mature as our seniors. If it be true that a man has attained his mental growth by his twentieth year, then it is of vital importance that teacher and parent alike appreciate the true functions of school and college training and the part which each can effectively play in the development of a man.

To quote Mr. Flexner on this point: "As a matter of fact, the early years are of the most vital consequence to an education that proposes the exploitation of the individual on native lines."*

Chiefly because of its value to ourselves in revealing our duties more clearly, we feel, with an optimism which it is hoped time will justify, that this course for the Underclassmen is the most important step we have taken since the present personnel composed the staff of electrical engineering at Stanford University.

* "The American College," by Abraham Flexner, p. 66.

REPORT OF THE COMMITTEE ON ENTRANCE REQUIREMENTS.

(*Concluded from May* BULLETIN.)

FRENCH.

The definitions of the requirements in French follow the recommendations of the Committee of Twelve of the Modern Language Association.

FORMULATION VIII.—Two units.

a. The Elementary Requirement.

The Aim of the Instruction.—At the end of the elementary course the pupil should be able to pronounce French accurately, to read at sight easy French prose, to put into French simple English sentences taken from the language of everyday life, or based upon a portion of the French text read, and to answer questions on the rudiments of the grammar as defined below.

The Work to be Done.—During the first year the work should comprise: (1) Careful drill in pronunciation; (2) the rudiments of grammar, including the inflection of the regular and the more common irregular verbs, the plural of nouns, the inflection of adjectives, participles, and pronouns; the use of personal pronouns, common adverbs, prepositions, and conjunctions; the order of words in the sentence, and the elementary rules of syntax; (3) abundant easy exercises, designed not only to fix in the memory the forms and principles of grammar, but also to cultivate readiness in the reproduction of natural forms of expression; (4) the reading of from 100 to 175 duodecimo pages of graduated texts, with constant practice in translating into French easy variations of the sentences read (the teacher giving the English), and in reproducing from memory sentences previously read; (5) writing French from dictation.

During the second year the work should comprise: (1) the reading of from 250 to 400 pages of easy modern prose in the form of stories, plays, or historical or biographical sketches; (2) constant practise, as in the previous year, in translating into French easy variations upon the texts read; (3) frequent abstracts, sometimes oral and sometimes written, of portions of the text already read; (4) writing French from dictation; (5) continued drill upon the rudiments of grammar, with constant application in the construction of sentences; (6) mastery of the forms and use of pronouns, pronominal adjectives, of all but the rare irregular verb forms, and of the simpler uses of the conditional and subjunctive.

Suitable texts for the second year are: About's Le roi des Montagnes, Bruno's Le tour de la France, Daudet's easier short tales, La Bedolliere's La Mere Michel et son chat, Erckmann-Chatrian's stories, Foa's Contes biographiques and Le petit Robinson de Paris, Foncin's Le pays de France, Labiche and Martin's La poudre aux yeux and Le voyage de M. Perrichon, Legouve and Labiche's La cigale chez les fourmis, Malot's Sans famille, Mairet's La tache du petit Pierre, Merimee's Colomba, extracts from Michelet, Sarcey's Le siege de Paris, Verne's stories.

FORMULATION IX.—One unit.

b. The Intermediate Requirement.

At the end of the intermediate course the pupil should be able to read at sight ordinary French prose or simple poetry, to translate into French a connected passage of English based on the text read, and to answer questions involving a more thorough knowledge of syntax than is expected in the elementary course.

The Work to be Done.—This should comprise the reading of from 400 to 600 pages of French of ordinary difficulty, a portion to be in the dramatic form; constant practise in giving French paraphrases, abstracts or reproductions from memory of selected portions of the matter read; the study of a grammar of moderate completeness; writing from dictation.

Suitable texts are: About's stories, Augier and Sandeau's Le Gendre de M. Poirier, Beranger's poems, Corneille's Le Cid and Horace, Coppee's poems, Daudet's La Belle-Nivernaise, La Brete's Mon oncle et mon cure, Madame de Sevigne's letters, Hugo's Hermani and La chute, Labiche's plays, Loti's Pecheur d' Islande, Mignet's historical writings, Moliere's L'avare and Le bourgeois gentilhomme, Racine's Athalie, Andromaque, and Esther, George Sand's plays and stories, Sandeau's Mademoiselle de la Seigliere, Scribe's plays, Thierry's Recits des temps merovingiens, Thiers's L'expedition de Bonaparte en Egypte, Vigny's La canne de jonc, Voltaire's historical writings.

Credit for Advanced French, in accordance with the recommendations of the Committee of Twelve, will be given when there is occasion for it.

GERMAN.

The definition of requirements in German are based upon the recommendations of the Committee of Twelve of the Modern Language Association.

FORMULATION X.—Two units.

a. The Elementary Requirement.

The Aim of the Instruction.—At the end of the elementary course in German the pupil should be able to read at sight, and to translate, if called upon, by way of proving his ability to read a passage of very easy dialogue or narrative prose, help being given upon unusual words and constructions, to put into German short English sentences taken from the language of everyday life or based upon the text given for translation, and to answer questions upon the rudiments of the grammar, as defined below.

The Work to be Done.—During the first year the work should comprise: (1) careful drill upon pronunciation; (2) the memorizing and frequent repetition of easy colloquial sentences; (3) drill upon the rudiments of grammar, that is, upon the inflection of the articles, of such nouns as belong

to the language of everyday life, of adjectives, pronouns, weak verbs, and the more usual strong verbs; also upon the use of the more common prepositions, the simpler uses of the modal auxiliaries, and the elementary rules of syntax and word order; (4) abundant easy exercises designed not only to fix in mind the forms and principles of grammar, but also to cultivate readiness in the reproduction of natural forms of expression; (5) the reading of from 50 to 100 pages of graduated texts from a reader, with constant practice in translating into German easy variations upon sentences selected from the reading lesson (the teacher giving the English), and in the reproduction from parts of readers available for first year's class-work; good selections may be made from Müller und Wenckebach's Glück Auf; Kern's (Grimm's) German Stories Retold; Guerber's Märchen and Erzählungen; Seeligmann's Altes and Neues.

During the second year the work should comprise: (1) the reading of from 150 to 200 pages of literature in the form of easy stories and plays; (2) accompanying practise, as before, in the translation into German of easy variations upon the matter read, and also in the off-hand reproduction, sometimes orally and sometimes in writing, of the substance of short and easy selected passages; (3) continued drill upon the rudiments of the grammar, directed to the ends of enabling the pupil, first, to use his knowledge with facility in the formation of sentences, and, secondly, to state his knowledge correctly in the technical language of grammar.

Stories suitable for the elementary course can be selected from the following list: Andersen's Märchen und Bilderbuch ohne Bilder; Arnold's Fritz auf Ferien; Baumbach's Die Nonna and Der Schwiegersohn; Gerstacker's Germelshausen; Heyse's L'Arrabbiata, Das Mädchen von Treppi, and Anfang und Ende; Hillern's Höher als die Kirche; Jensen's Die braune Erica; Leander's Traumereien, and Kleine Geschichten, Seidel's Marchen; Stokl's Unter dem Christbaum; Storm's Immensee and Geschichten aus der Tonne; Zschokke's Der zerbrochene Krug.

Good plays adapted to the elementary course are much harder to find than good stories. Five-act plays are too long. They require more time than it is advisable to devote to any one text. Among shorter plays the best available are perhaps Benedix's Der Prozess, Der Weiberfeind, and Gunstige Vorzeichen; Elz's Er ist nicht eifersuchtig; Wichert's An der Majorsecke; Wilhelmi's Einer muss heiraten. It is recommended, however, that not more than one of these plays be read. The narrative style should predominate. A good selection of reading matter for the second year would be Andersen's Marchen, or Bilderbuch, or Leander's Traumereien, to the extent of say forty pages. After that such a story as Das kalte Herz, or Der zerbrochene Krug; then Hoher als die Kirche, or Immensee; next a good story by Heyse, Baumbach, or Seidel; lastly Der Prozess.

FORMULATION XI.—One unit.

b. The Intermediate Requirement.

The Aim of the Instruction.—At the end of the intermediate course the pupil should be able to read at sight German prose of ordinary difficulty, whether recent or classical; to put into German a connected passage of simple English, paraphrased from a given text in German; to answer any grammatical questions relating to usual forms and essential principles of the language, including syntax and word-formation, and to translate and explain (so far as explanation may be necessary) a passage of classical literature taken from some text previously studied.

The Work to be Done.—The work should comprise, in addition to the elementary course, the reading of 300 to 400 pages of moderately difficult prose and poetry, with constant practice in giving, sometimes orally and sometimes in writing, paraphrases, abstracts, or reproductions from memory of selected portions of the matter read; also grammatical drill upon the less usual strong verbs, the use of articles, cases, auxiliaries of all kinds, tenses and modes and likewise upon

word-order and word-formation. A text-book, such as Harris', Wesselhoeft's, or Berhardt's, German Composition, should be used for this purpose.

The intermediate course is supposed to be the elementary course, plus one year's work at the rate of five recitations per week. Suitable reading matter for the third year can be selected from such works as the following: Ebner-Eschenbach's Die Freiherren von Gemperlein; Freytag's Die Journalisten und Bilder aus der deutschen Vergangenheit—for example, Karl der Grosse, Aus den Kreuzzügen, Doktor Luther, Aus dem Staat Friedrichs des Grossen; Fouque's Undine; Gerstäcker's Irrfahrten; Goethe's Hermann und Dorothea and Iphigenie; Heine's poems and Reisebilder; Hoffmann's Historische Erzählungen; Lessing's Minna von Barnhelm; Meyer's Gustav Adolfs Page; Moser's Der Bibliothekar; Riehl's Novellen—for example, Burg Neideck, Der Fluch der Schönheit, Der stumme Ratherr, Das Spielmankind; Rosegger's Waldheimat; Schiller's Der Neffe als Onkel, Der Geistersher, Wilhelm Tell, Die Jungfrau von Orleans, Das Lied von der Glocke, Balladen; Scheffel's Der Trompeter von Säkkingen; Uhland's poems; Wildenbruch's Das edle Blut.

Credit in Advanced German, in accordance with the recommendations of the Committee of Twelve, will be given when there is occasion for it.

SPANISH.

The definition of requirements in Spanish follow the recommendation of the College Entrance Examination Board.

FORMULATION XII.—Two units.

a. During the first year the work should comprise (1) careful drill in pronunciation; (2) the rudiments of grammar, including the conjugation of the regular and the more common irregular verbs, the inflection of nouns, adjectives and pronouns, and the elementary rules of syntax; (3) exercises containing illustrations of the principles of grammar; (4) the

reading and accurate rendering into good English of from 100 to 175 duodecimo pages of graduated texts, with translation into Spanish of easy variations of the sentences read; (5) writing Spanish from dictation.

b. During the second year the work should comprise: (1) the reading of from 250 to 400 pages of modern prose from different authors; (2) practise in translating Spanish into English, and English variations of the text into Spanish; (3) continued study of the elements of grammar and syntax; (4) mastery of all but the rare irregular verb forms and of the simpler uses of the modes and tenses; (5) writing Spanish from dictation; (6) memorizing of easy short poems.

Suitable texts for the second year are: Valera's El pajaro verde; Alarcon's El final de Norma; Valdes's José; Galdos's Dona Perfecta, Marianela; Padre Isla's version of Gil Blas; Carrion and Aza's Zaragueta.

LATIN.

Formulation XIII.

In Latin the first two units are based upon the definitions proposed by the American Philological Association, and the third and fourth units upon the definitions proposed by the College Entrance Examination Board.

(*a*) Latin lessons, accompanied from an early stage by the reading of very simple selections. Easy reading: twenty to thirty pages of consecutive text.

In all written exercises the long vowels should be marked, and in all oral exercises pains should be taken to make the pronunciation conform to the quantities.

The student should be trained from the beginning to grasp the meaning of the Latin before translating, and then to render into idiomatic English; he should also be taught to read the Latin aloud with intelligent expression. One unit.

(*b*) Selections from Cæsar's Gallic War equivalent in amount to four books; selections from other prose writers, such as Nepos, may be taken as a substitute for an amount up to, but not exceeding, two books.

The equivalent of at least one period a week in prose composition based on Cæsar.

Reading aloud and translating, together with training in correct methods of apprehending the author's meaning, both prepared and unprepared passages being used as material. The memorizing of selected passages. One unit.

(*c*) Cicero: Any six orations from the following list, but preferably the first six mentioned:

The four orations against Catiline, Archias, the Manilian Law, Marcellus, Roscius, Milo, Sestius, Ligarius, the fourteenth Philippic.

Vergil: The first six books of the Aeneid.

The equivalent of at least one period a week in prose composition based on Cicero.

Note: In place of a part of Cicero an equivalent of Sallust's Catiline, and in place of a part of Vergil an equivalent of Ovid will be accepted. Two units.

HISTORY.

The definition of requirement in history is that recommended by the Committee of Seven of the American Historical Association.

FORMULATION XIV.

(*a*) Ancient history, with special reference to Greek and Roman history, and including also a short introductory study of the more ancient nations and the chief events of the early Middle Ages, down to the death of Charlemagne (814). One unit.

(*b*) Mediæval and modern European history, from the death of Charlemagne to the present time. One unit.

(*c*) English history. One unit.

(*d*) American history and civil government. One unit.

Each of the above topics is intended to represent one year of historical work wherein the study is given five times per week, or two years of historical work wherein the study is given three times per week.

This is contrary to the practise of many secondary schools

which give only one-half of this time to English history and American history, although it is common in these schools to give one-half year to the study of civil government, which together with the half-year devoted to American history will make the required unit.

PHYSICAL GEOGRAPHY.

FORMULATION XV.—One Unit.

The following outline condensed from a report of the Committee on Definition of Physical Geography of the North Central Association of Colleges and Secondary Schools, includes only the essential facts and principles of physical geography, which must be studied in the class room and laboratory:

The Earth as a Globe.—Shape of earth: How proved; probable causes of. Size: How measured. Rotation: Day and night; longitude and time; latitude. Revolution: Rate path; direction. Seasons and their causes. Magnetism: Compass; variation in. Map projection explained.

The Land.—Distribution. Graphic representation of topography. Changes in land areas and in land forms: Effects of (1) elevation and depression, of (2) disposition of sediments, (3) of shore erosion. Plains: Effect of climate and rock structure on topography of plains. Alluvial plains: their formation and importance. Relation of life to different forms of plains. Plateaus: Relations to plains and to mountains. Effect of climate, rock structure, etc., on topography of plateaus. Locations of the great plateaus. Life conditions on plateaus. Mountains: Classes. History. Effects of climate, rock structure, etc., on mountain topography. Life conditions in mountains. Volcanoes: Distribution. Phenomena of eruptions. History of a volcano. Influence of volcanoes on topography and life. Rivers: The work of rivers. The topography of surfaces shaped by river erosion at different stages of valley development. The great drainage basins of the United States. Lakes: The distribution of lakes, particularly in North America. The changes which they are undergoing.

Their effect on climate. Their relations to life in general. Glaciers: The nature of glacier ice. The distribution of glaciers. The conditions necessary for glaciers. The work of glaciers.

The Atmosphere.—Composition and offices of atmosphere. Instruments used in study of atmosphere. Temperature: Source of atmospheric heat, and variations of atmospheric temperatures. Isothermal charts. Pressure: Measurement of pressure. Determination of altitudes by atmospheric pressure. Relation to temperature. Study of isobars. Circulation of atmosphere: Winds; their causes; their classes; and their effects. Moisture: Sources. Conditions for precipitation. Forms of precipitation; rain and snow; dew and frost. Relation of precipitation to life. Storms: Relation of storms to general weather conditions. Study and construction of weather maps. Relation of weather to climate. Relation of climate and weather to life and to human industries.

The Ocean.—Form, divisions and general characteristics of the ocean, and of ocean basins. Depth, density and temperature of ocean waters. Characteristics of ocean floor; topography, material, etc. The life of the oceans. Movement of ocean waters: Waves; cause and effect. Currents; effects of currents on climate, life, etc. Tides: character of motion; causes of tides; variation of tides, and their causes; bores; effect of tides on navigation, harbors, etc. Work of ocean; Erosion and deposition. Shore lines: Influence of harbors and coast lines.

Summary.—The outline given can but enumerate the larger topics to be covered, and in a way suggest the point of view desired. Each topic should be treated so as to show its causal relations to other topics. So far as possible, the effects of earth features on life (especially human life) conditions should be emphasized.

Throughout the work an effort should be made to develop the student's ability to use the data presented. The acquisition of the facts presented in the text-books is in itself of relatively little value. The student should be taught to apply,

out-of-doors and in the laboratory, the principles developed in the class room. When he can do this, and when he can utilize and combine the data presented in the books in new ways and to new ends, one of the chief aims of the study will have been accomplished.

The candidate's preparation should include:

(*a*) The study of one of the leading secondary text-books in physical geography, for the sake of essential principles, and of well-selected facts illustrating those principles.

(*b*) Individual laboratory work should occupy from one fourth to one half of the time of the student in the class-room. Field trips should take the place of some of the laboratory work in autumn and spring. The results of laboratory work should be carefully recorded in writing, and in many cases should be made the basis of class-room discussion. Similarly the field work should be made the basis of written reports or of subsequent class-room discussion, or both. In general, the laboratory and the field should be made to afford illustrations of as many principles and phenomena as possible.

MANUAL TRAINING.

Shop Work and Drawing.

Much difficulty has been experienced in formulating definitions of requirements of subjects in the mechanic arts. In fact, there is practically no general unanimity of opinion as to definitions of these subjects. The time element enters very largely into these definitions since practise must necessarily constitute a valuable part of the work and the measure of work accomplished is largely determined by the time spent on the subject.

What is meant by manual training has been discussed by educators for a number of years. Your Committee on Entrance Requirements for Engineering Colleges formerly failed to agree as to what should be included under manual training or how this subject should be defined.

The subject was under discussion for a year or two before the Eastern Manual Training Association and the decision

arrived at by that body was that the time devoted to a given subject be accepted as a unit of manual training work, but what this work should consist of or how it should be administered was not stated.

More, recently, 1907 and 1908, the Committee of the North Central Association of Colleges and Secondary Schools (C. M. Woodward past-President of this Society, Chairman) considered this question, and reported essentially as follows:

"We have, therefore, defined shop-work and drawing, as it exists, or should exist, in a well-organized and fully equipped city manual training high school. If for any reason a high school undertakes less than the full amount we specify, we recommend that it take up subjects in the order we name them and cover the ground thoroughly, as far as it goes. A high school is not, and cannot be, a high-grade technical school, and nothing is gained by skipping the broad foundations of manual and graphic culture and attempting prematurely to do engineering work."

Formulation XVI.

The minimum time given per year in order to count as a unit should not be less than the equivalent of 240 hours of 60 minutes each. No superior limit is given, but additional hours should not receive additional credit.

Shopwork.

Every exercise which is involved in what follows should be planned and executed to illustrate an important mechanical principle or process, or a combination of such principles and processes.

The exposition of a tool and the demonstration of a process should be before the entire section of pupils conveniently seated so as to see all that the teacher does, and hear all that he says.

The shop-period of first-year boys ought not to exceed 100 minutes in length; but third and fourth year pupils can profitably have longer, but less frequent shop-periods; however, those periods should never exceed 180 minutes.

Pupils should never be left to find out for themselves the proper ways of using a tool. The correct ways should be clearly and fully shown and explained. The use of a wrong tool, and the adoption of an illogical or unscientific procedure should at once be checked, and the error should be plainly pointed out.

Bench Work (One unit).

(*a*) Fundamental tool processes: Measuring, squaring, gauging, sawing, boring, chiseling; rules for planing.

(*b*) Constructions involving groove joints and halving; laying out and cutting joints; use of nails, screws and glue; carving and finishing.

(*c*) Making a glue joint; planing joints, gluing, clamping, surfacing, sandpapering.

(*d*) Construction by means of mortise-and-tenon joint; laying out duplicate parts, cutting mortise, sawing tenon, gluing and clamping, scraping, finishing.

(*e*) Construction involving the miter joint; planing parallel edges and sides in the construction of a miter box; rebating, laying out and cutting a brace.

(*f*) Dovetailing: laying out and cutting dovetails, planing corners, inlaying.

(*g*) Construction involving the use of the panel: plowing, fitting, gluing, clamping, putting on hinges, finishing.

Wood-Turning and Elementary Metal-Working (One unit).

1. Wood-turning. Use of different kinds of wood. Care of lathe.

(*a*) Turning spindle, cylinder, taper, convex curve, concave curve, compound curve; turning to given dimensions, finishing and polishing in the lathe.

(*b*) Faceplate turning.

(*c*) Chuck turning; built-up stock, fitting.

2. Metalworking. Working in a variety of metals, including cast-iron, steel, brass, tin, zinc, and copper.

(*a*) Chipping and filing; chipping with cold chisel and hammer; filing, testing, tool dressing.

(*b*) Making small tools. Drilling, filing, fitting, riveting, finishing.

(*c*) Construction in sheet metal; pattern cutting, bending, folding, wiring, soldering.

(*d*) Copper work: sawing, beating, hard soldering, repoussé, annealing, coloring with heat and chemicals, etching.

(*e*) Turning: Hand-tool turning, filing in lathe, polishing in lathe, thread cutting with tap and die, hardening, tempering, annealing.

(*f*) Spinning: cutting templet, turning form in wood to fit templet, spinning zinc or Britannia metal and copper, polishing, lacquering.

Pattern Making, Molding and Forging (One unit).

The theory and use of patterns, how built, how divided and why; pattern-making, bench-molding of simple and complex patterns; theory and use of cores, construction of cores and core-prints; casting with lead and alloys.

Construction and management of the forge—fundamental processes; drawing, up-setting, bending, punching, splitting, welding, hardening; shaping steel under the hammer; tempering of different grades; the construction of chains, hooks and forge tools, and wrought-iron articles from original or selected designs; finally the manufacture of a set of standard steel lathe tools. The design and actual construction of a piece of ornamental wrought-iron or steel work.

Bench and Machine Metal Fitting (One unit).

Theory of metal-turning, centering; forms of cutting tools and tool-grinding; turning cast-iron, wrought-iron, steel, and brass; use of oil, relation of speed to heat developed; use of taps and dies; screw cutting, chuck-work, mandril and face-plate work; drilling, slotting, planing, gear-cutting, and special work on the milling machine. Having mastered the elements, each student should combine more or less of such elements in a construction, made in accordance with original or selected drawings.

MECHANICAL DRAWING.

FORMULATION XVII.—Two units.

1. (*a*) Straight lines; use of T-square, triangles, pencil, ruling pen, dividers, and scale. Conventional lines. Free-hand working sketches.

(*b*) Circles. Use of compasses, center lines, crosshatching.

(*c*) Tangents. Location of centers and points of tangency.

(*d*) Planes of projection; elementary principles of projection; revolution of the planes of projection. Projections of simple geometric figures.

(*e*) Revolution of objects. "Views" of objects in simple and inclined positions.

(*f*) Developments: prism, cylinder, pyramid, cone.

(*g*) Intersections. Axes in the same plane, axes in different planes.

(*h*) Isometric and cabinet drawing.

(*i*) Freehand and mechanical lettering; placing, form slant, spacing, stroke.

(*j*) Working drawings; furniture.

(*k*) Working drawings; machine parts.

(*l*) Building plans; floor plans, elevations.

2. (*a*) Mechanical perspective.

(*b*) Freehand drawing in perspective.

(*c*) Construction of conic sections and helix.

(*d*) Line shading.

(*e*) Wash drawing.

(*f*) Designing for metal work.

(*g*) Either machine or architectural drawing.

The Committee on Manual Training of the North Central Association of Colleges and Secondary Schools has also presented (1909) the following definitions of requirements in Free-hand drawing and applied art:

FREE-HAND DRAWING AND APPLIED ART.

FORMULATION XVIII.—Two units.

Approximately one-third the time should be given to representative drawing and two-thirds to decorative composition,

constructive and decorative design, construction and applied design.

(*a*) Pictorial. Plant study (flowers, sprays of leaves, seed, pods, etc.). Object study; landscape, roof studies, buildings, etc.; pose drawing; composition.

(*b*) Decorative Composition. Plant forms, object study, landscape, pose.

(*c*) Decorative Design. Plant analysis (for the purpose of design). Conventionalized plant forms; decorative units, borders, surfaces, corners, rosettes, posters, book-covers, etc.; stencils, wood-block printing; historic ornament; arrangement of straight lines, and of straight and curved lines; geometric design; lettering, illuminating; schemes for interior decoration.

(*d*) Constructive Design. Designs for pottery, leather, metal, book-binding, furniture, cardboard construction, textiles, etc.

(*e*) Crafts. Pottery, leather, metal, book-binding, furniture. (Choice of one or more of the above crafts.)

(*f*) Applied Design. Design applied to the crafts and to cardboard, textiles, etc.

(*g*) Illustration.

(*h*) Talks on history of industry and art, on civic planning, domestic architecture and decoration.

(*i*) Instrumental drawing to be given as needed to meet the requirements of practical designing and construction.

Note. Mediums used—pencil, charcoal, water color, crayons, brush and ink, and a combination of the pure mediums.

(Signed)

J. P. JACKSON,
C. D. MARX,
F. O. MARVIN,
F. W. MCNAIR,
J. C. NAGLE,
J. J. FLATHER,
Chairman.